ARTICLE VI.

On the Magnetic Dip at several places in the State of Ohio, and on the relative Horizontal Magnetic Intensities of Cincinnati and London. By John Locke, M. D., Professor of Chemistry and Pharm., Medical College of Ohio. In a letter to John Vaughan, Esq., Librarian of the Am. Philos. Soc. Read June 15, 1838.

THE extent of our continent and sea coast, the importance of our navigation, and our proximity to the magnetic pole, all conspire to render accurate magnetical observations highly interesting and useful. Yet, if we except the labours of Professors Bache and Courtenay, very little has been done by our countrymen, in this department of science. So far as I know, nothing has yet been communicated from this side of the Alleghanies. In my late journey abroad, it was no inconsiderable object with me, to procure the instruments and the instructions necessary for determining the elements of Dip, Declination, and Intensity, especially in the western part of the United States. On arriving in London, I was not a little gratified to find in the hands of one of our own countrymen, Professor Bache, an apparatus invented by himself, so perfectly adapted to the purpose of determining the Horizontal Intensity, by the vibration of the Hansteenian needles in a rarified medium, that I at once ordered one to be made after the same model, by the very skilful artisan Mr Robinson, of Devonshire street, London. It has not disappointed my expectations. It is portable, easy of manipulation, and gives results as consistent and satisfactory as the present

state of our knowledge of the subject would authorize us to expect. I furnished myself with a dipping apparatus, and two six inch needles, adapted to it, made also by Robinson; a chronometer made by Molyneux & Sons, and a declination or variation apparatus made by Troughton & Simms. I am under obligations to Professor Bache, for the kind manner in which he communicated to me his mode of manipulation, and for the opportunity of witnessing his experiments, both at Westbourn Green and at the observatory of Paris. It would seem to be a very simple operation to count the vibrations of a freely suspended magnetic needle, and note their time by a chronometer; to perform the various reversals with the dipping apparatus, &c., &c.; yet, although not destitute of mechanical skill and experience, it was not until I had had considerable practice, that I could proceed with confidence and certainty. It had been my intention to make a series of observations at or near to London, so often repeated as to be able to refer my observations on intensity especially, to the intensity of that place as unity. But the delay of workmen to finish my instruments, and the pressure of other business, permitted me to make only a single series.

The needles which I used for determining horizontal intensity were three in number; two of them, Nos. 1 and 2, were of the Hansteenian model, cylindrical, terminating in cones, one-eighth of an inch in diameter, two and a half inches long, and weighing, with thin, light brass stirrups for suspension, about sixty-five grains each. The third, No. 3, was a flat needle, three inches long, one-fourth of an inch wide, and about one-fortieth of an inch thick, terminating in an angle or point of about sixty degrees, at each end, and weighing forty-four grains. Through the politeness of Mr Airy, the astronomer royal, I was enabled to vibrate these needles contiguous to the observatory at Greenwich, and on the site lately laid off for a magnetical observatory. From the vibration of these needles at Greenwich, August 26, 1837, and at Cincinnati, January 17, 1838, in both cases in a medium so rarified as to support only half an inch of mercury, after proper reduction for temperature, &c., I obtained indications of the ratio of horizontal intensity at the former place, to that of the latter, as follows.

By needle No. 1, 1 to 1·1624; by needle No. 2, 1 to 1·1639; by No. 3, 1 to 1·2037. I attribute the disagreement of the results obtained by Nos. 1 and 2, and that obtained by No. 3, to a probable di-

minution of the magnetism in the two former by means of the application of "keepers," strips of soft iron to join their dissimilar ends. The vibrations with No. 3 were twice repeated, and extended each time to five hundred, in number; and as the magnetism of the needles is liable to decrease, but not liable to increase, I attach the greater importance to the last result, and would therefore conclude that the horizontal intensity at Greenwich is, to that at Cincinnati, as 1 is to 1·2037. But little weight can, however, be attached to these observations, until they shall have been verified by repetition. I am, therefore, very desirous, that after I shall have fully ascertained here the properties of these needles, I may be enabled to send them again to Greenwich, have them vibrated satisfactorily there, and returned to be verified again in America.

It is not my intention, at this time, to go into the details of my observations on Intensity; this I will defer until my experiments shall have been more extensive. I will now proceed to give you the results of my experiments with the Dipping apparatus, at London and at several places in Ohio.

August 20th, 1837, I proceeded to the celebrated station of Westbourn Green, near London, where Captain Ross has made many of his observations, and obtained the following results:

No. of Needle.	Polarity.	Limb of Instrument.	Face of Needle.	Indication.	Mean.
1.	A	E	E	69° 15′	
		E	W	69 43½	
		W	E	69 06	
		W	W	69 40	
	B	W	W	69 03½	
		W	E	69 44	
		E	W	69 10	
		E	E	69 24	69° 23′·25
2.	A	E	E	70 12½	
		E	W	68 48	
		W	E	69 56	
		W	W	68 40	
	B	W	W	69 46	
		W	E	68 49	
		E	W	70 08½	
		E	E	68 47½	69° 23′·4375
					69° 23′·3437

These observations were made between the hours of twelve and two, P. M., the mean temperature being 86° F. In the experiments made at the same place by Captain Ross, as quoted by Professor Lloyd in the Fifth Report of the British Association,

"Needle B" gave the dip 69° 01′·5,
"Needle P", " " " 69 42·0,

and these were the extremes; from the mean of which my mean result differs only two minutes. It differs, however, from the mean of all Captain Ross's experiments, with eight different needles, near six minutes of a degree.

The following results were obtained at the garden of N. Longworth, Esq., in Cincinnati, latitude 39° 6′ N., longitude 84° 27′ W., November 26, 1837.

No. of Needle.	Polarity.	Limb of Instrument.	Face of Needle.	Indication.	Mean.
1.	A	E	E	70° 32′	
		E	W	70 56	
		W	E	70 39	
		W	W	70 53	
	B	E	E	71 20	
		E	W	70 25	
		W	E	71 21	
		W	W	70 10	70° 47′
2.	A	E	E	71 20	
		E	W	70 20	
		W	E	71 15	
		W	W	70 14	
	B	E	E	70 33	
		E	W	70 51	
		W	E	70 33	
		W	W	70 50	70° 44′·5
					70° 45′·75

At Dayton, in the state of Ohio, latitude 39° 44′ N., longitude 84° 11′ W., March 26, 1838, the dip

by No. 1, was	71° 23′
by No. 2,	71 22·5
Mean,	71° 22′·75

Time, 9 to 11, A. M.; temperature 70°, F.

At Springfield, latitude 39° 53′ N., longitude 83° 46′ W., March 29, 1838, the dip

by Needle No. 1, was,	71° 26′
by " No. 2,	71 28·75
Mean,	71° 27·375

Time 6 to 8 o'clock, A. M.; temperature 53°, F.

Professor Lloyd, in the account of his "Magnetical Observations in Ireland," points out, very clearly, the fact that there is, in some dipping needles, "a source of *constant* error, which remains uncorrected by the various reversals usually made." He proposes to ascertain this error, and "apply it as a correction to all future results within certain limits." From my observations at Springfield, I became satisfied that the discrepancy between the results with the two needles, 2′·75, arose from a want of perfect roundness in the pivots of one needle; for it showed itself only at one of the reversals of polarity, and totally disappeared at other places, where the dip was either a little more or a little less, so as to throw the pivot on another point of bearing. Such mechanical errors would be expected; yet when they are so small as above, they are scarcely worth noticing, unless to point out their nature. If the above view is correct, the "error" is far too limited in its operation to justify the application of a correction which had been made at any one place, to observations made at another. When it amounts to as much as "twenty minutes," it certainly shows a needle of bad mechanical qualities.

At Urbana, latitude 40° 03′ N., longitude 83° 44′ W., March 30, 1838, the dip by needle No. 1, was 71° 30′·44; by No. 2, 71° 29′·44. Mean, 71° 29′·94.

At Columbus, the seat of government for the state of Ohio, latitude 39° 57′ N., longitude 83° 00 W., I had expected the dip to be nearly

as at Springfield, in nearly the same latitude, but was surprised to find it as follows.

By needle No. 1, 71° 04′·5; by needle No. 2, 71° 05′·25; mean, 71° 04′·875. The above observations were made in a field not far east from the state house, April 3, 1838, from eight to nine o'clock, A. M., temperature 40°. Suspecting local attraction, I removed to a wood, north west of the lunatic asylum, and went through with another series, which gave the following results.

Needle No. 1, 71° 04′·375; No. 2, 71° 05′·375; mean, 71° 04′·875, as before. Time, ten to eleven o'clock: temperature 43°. As these results agree identically, I will give the observations in full.

No. of Needle.	Polarity.	Limb of Instrument.	Face of Needle.	Indication. 1st Experiment.	Mean.	Indication. 2d Experiment.	Mean.
1.	A	E	E	70° 55′		70° 53′	
		E	W	71 30		71 27	
		W	E	70 45		70 47	
		W	W	71 25		71 21	
	B	E	E	71 40		71 45	
		E	W	70 24		70 25	
		W	E	71 35		71 39	
		W	W	70 22	71° 04′·5	70 18	71° 04′·875
2.	A	E	E	71 35		71 39	
		E	W	70 32		70 29	
		W	E	71 38		71 37	
		W	W	70 28		70 27	
	B	E	E	71 00		70 58	
		E	W	71 26		71 31	
		W	E	70 45		70 40	
		W	W	71 18	71° 05·25	71 22	71° 05′·375
					71° 04′·875		71° 04′·875

As we cannot rely upon observations of this kind, but within a certain latitude of error, I consider the *identity* of the above results a matter of accident. In making the last observations, no reference was made to the minutes of the first, lest an insensible leaning should be given to the mind to make them agree.

The latitude and longitude of the several places, except Cincinnati,

is only an approximation, by admeasurement, of a map supposed to be accurate.

It appears from these observations, and those that have been made in the Atlantic cities, that although the lines of equal dip, in travelling from Britain westwardly, decline rapidly to the south, yet they attain their greatest southing before they reach our continent, for we find them, on the whole, in passing from the Atlantic to Ohio, proceeding rather north of west. The line of dip equal to that of Philadelphia, latitude 39° 57′ N., would pass through the western part of Ohio, in latitude 40° 43′ N.; still, in Ohio itself, these lines are again declining to the south; for the line of equal dip of Columbus, in latitude 39° 57′, would cross the meridian of Cincinnati, in latitude 39° 27′, declining half a degree of latitude in 1° 27′ of longitude. It is my intention to extend these observations over as large a portion of the western states as possible. The results, together with those for determining Intensity and Declination, I hope to be able to communicate to you at an early period.

Very respectfully,

Your obliged friend, and

Humble servant,

JOHN LOCKE.

Cincinnati, May 7, 1838.